AD-A286 567

R & D STATUS REPORT

DARPA ORDER NO: 8100 **PROGRAM CODE NO:** DO-C9

CONTRACTOR: David Sarnoff Research Center

CONTRACT NO.: N00014-91-C-0216 **CONTRACT AMOUNT:** $1,585,150

EFFECTIVE DATE OF CONTRACT: 26 August 1991

EXPIRATION DATE OF CONTRACT: 25 August 1994

PRINCIPAL INVESTIGATOR: Dr. Edgar J. Denlinger

TECHNICAL CONTRIBUTORS: Dr. Aly Fathy, David Kalokitis,
Valerie Pendrick,
Dr. Barry Thaler,
Dr. K. S. Harshavardhan (Neocera),
Dr. T. Venkatesan (Neocera)

TELEPHONE NO: (609) 734-2481

SHORT TITLE OF WORK: High Performance YBCO Films

REPORTING PERIOD: 8/25/94 to 11/25/95

1 The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the Defense Advance Research Projects Agency of the U.S. Government.

TABLE OF CONTENTS

SUMMARY

- The focus for the remainder of our program, which will end during the next quarter, is on oxygen annealing the buried YBCO ground plane through the Ag power plane and glass/metal handle as well as making an MCM structure with YBCO being used for only the signal layer.
- Oxygen annealing of a YBCO-covered lanthanum aluminate through five microns of thermally evaporated silver, after subjecting the sample to glass-firing conditions, recovered the microwave Q of the sample to within 16-18% of its original value (measured before the silver was deposited). The oxygen annealing time was only 4 hours. This Q degradation is believed to be acceptable for the YBCO ground plane of an MCM module. Addition of the STO dielectric layer between the YBCO ground plane and the silver makes the oxygen annealing time very long (>18 hours).

I. INTRODUCTION

An MCM technology based on a YBCO/bulk magnesium fluoride microstrip structure and attached to a glass/metal handle is being developed. Due to the unavailability of 1995 funding for the final phase of this contract, we are now focusing on the following tasks with the remaining funds for the program, which is now planned to end 2/28/95:

(1). oxygen annealing of the buried YBCO ground plane through the silver buffer layer and the glass/metal handle;

(2). fabrication and testing of an MCM glass/metal handle supported structure having a YBCO signal layer and a normal metal (silver) ground plane.

The following report discusses the progress in these two areas.

II. PROCESSING DEVELOPMENT OF MCM STRUCTURE

A. MgF_2 Substrates

Last quarter we reported on the use of vacuum annealing to improve the surface finish of MgF_2 after polishing by Sarnoff. This effort did not produce the desired results of improving the surface quality. However, in view of the new direction taken by the program, it will not be necessary to deposit YBCO on both sides of the MgF_2. Therefore, one side polished samples from the manufacturer will be adequate.

B. Glass/Metal Ha...e

As reported earlier the Bi_2O_3 glass was chosen for use with 5μm of Ag. We will continue to use this combination with the new structure.

C. YBCO Samples

A total of ten $LaAlO_3$ samples were received during this quarter. Table 1 gives a complete list of the $LaAlO_3$ samples received thus far in the program. Three samples, NGL15, 16, and 17 were STO/YBCO/$LaAlO_3$. The remaining seven samples did not have the STO cap layer. It was decided to stop using the STO cap layer due to the complications in annealing the YBCO samples after the Ag power plane was deposited. We reported earlier that STO/YBCO/$LaAlO_3$ samples required 18 hours of annealing in oxygen. This was without a Ag power plane. The samples with an STO cap layer have been given a low priority and will be used only for annealing experiments if time and resources permit.

Annealing tests continued with YBCO/$LaAlO_3$ samples. As reported in the last quarterly, we are using a thermal evaporator to deposit the Ag power plane. A calibration sample, JO12, YBCO/$LaAlO_3$, was used to track any differences in T_c and ΔT before and after the Ag evaporation along with any change Q. T_c and ΔT for the sample were 90K and 0.5K respectively and Q was measured to be 24,041. This data is for the sample in its "as received" state. These measurements were taken again after 5μm of Ag was evaporated. T_c and ΔT did not change; however, the measured Q dropped by 22%. This is very significant, because all of our conclusions are based on Q measurements. Samples which may appear to be unaffected by certain processing conditions (when measured by AC susceptibility) may indeed have suffered a degradation. The dielectric resonator provides extremely valuable information about the samples.

The above mentioned sample was annealed with flowing O_2 for five hours after the Ag deposition. The measured Q increased by 6% as a result of the annealing. However, additional annealing for ten hours did not result in any improvement. Measured Q dropped by 3%.

Based on the encouraging results from the annealing tests discussed above, Ag was deposited on two more samples, NGL21 and NGL22. Q dropped by 35% for NGL21 but only 18% for NGL22 after the Ag deposition. Since the Ag was deposited during the same run, its more likely that differences in the samples are the cause of the differing results than the Ag deposition itself. Sample NGL21 was fired in O_2 using the glass firing profile and then cooled to the YBCO

annealing temperature of 550°C and annealed at this temperature for 4 hours. Q improved to within 18% of the original value. This is very close to the results from J012, where Q improved to within 16% after annealing for 5 hours.

Table 1
LaAlO3 Samples

Sample	STO (Å)	Qo (front)	f (GHz) (front)	Qo (back)	f (GHz) (back)	Status
NGL1	4,000	30,472	24.876	33,546	22.651	As Recd.
NGL2	4,000	24,422	24.875	28,269	22.646	As Recd.
NGL3	4,000	28,323	24.850	33,349	22.645	As Recd.
NGL7	2,000	24,982	24.982	-	-	As Recd.
NGL9	2,000	22,481	24.871	-	-	As Recd.
NGL9A	2,000	23,800	24.864	30,095	21.698	As Recd.
NGL10	2,000	24,216	24.850	31,224	21.678	As Recd.
NGL11	2,000	23,774	24.849	-	-	As Recd.
NGL13	2,000	25,900	24.785	-	-	As Recd.
NGL15	2,000	19,332	24.852	-	-	As Recd.
NGL16	2,000	22,160	24.853	-	-	As Recd.
NGL17	2,000	20,500	24.847	-	-	As Recd.
NGL21	-	22,158	24.598	27,114	21.513	As Recd.
NGL22	-	24,000	24.611	26,748	21.529	As Recd.
NGL29	-	29,442	24.596	-	-	As Recd.
NGL30	-	30,424	24.605	-	-	As Recd.
NGL32	-	30,022	24.623	-	-	As Recd.
NGL34B	-	-	-	-	-	
NGL35	-	-	-	-	-	
J012	-	24,041	24.853	30,237	21.684	As Recd.

We will continue this investigation with sample NGL22. It is possible that Q will not be recovered completely after the Ag deposition, glass firing, and annealing. However, this is the strictest test applied to samples. For a sample with a Q of 30,000, a 15% drop would produce a Q of 25,500. This is still very good. Three of the most recently received samples, NGL29, NGL30, and NGL32, have measured Q values of 29,442, 30,424, and 30,022, respectively. A 15% decrease in these values would still be acceptable.

Two MgF_2 samples, NCF62 and NCF64 were received this quarter. All of the MgF_2 samples are summarized in Table 2. Ag was deposited on the two new samples along with two samples received during the last quarter, NCF54 and NCF55. Glass/handle structures were fabricated on all four samples. The handles, 1" x 1", were trimmed to the 1 cm x 1 cm size of the MgF_2 samples after the structure was assembled and fired. However, the poor adhesion between the Ag and glass on two samples caused them to separate after the handle was trimmed. The glass and Ag separated cleanly which allowed the samples to be reused. The separation was most likely the result of improper cleaning prior to the Ag deposition. Ag was redeposited and the handles were trimmed to the proper size prior to assembly. The MgF_2 on all four samples was thinned to 0.005" without any of the layers separating. However, there was some cracking of the MgF_2 on the edges where the MgF_2 and the handle were not perfectly aligned. This area of assembly needs to be improved. These samples will be used as calibration pieces for the laser deposition system and to further test the mechanical strength of the samples after heating in the laser chamber.

Table 2
MgF_2 Samples

Sample	STO (Å)	Qo (front)	f (GHz) (front)	Qo (back)	f (GHz) (back)	Status
NCF54	2,000	16,204	24.849	-	-	As Recd.
NCF55	2,000	17,700	24.846	-	-	As Recd.
NCF62	2,000	15,400	24.847	-	-	As Recd.
NCF64	2,000	15,100	24.829	-	-	As Recd.

D. MCM Fabrication

Fabrication of an MCM structure suitable for microwave/millimeter wave applications has been initiated. It will consist of a thinned 5 mil thick magnesium fluoride substrate having a YBCO signal layer, a normal silver ground plane, and a glass/metal handle support. The structure is shown in Figure 1. The objective is to demonstrate the ability to deposit a high quality YBCO signal layer on the glass/metal handle supported structure resulting in a structure that is useful for many microwave/mm-wave applications. When the

oxygenation of a buried YBCO ground plane is fully solved, the YBCO ground plane could be added in some future work beyond the current contract.

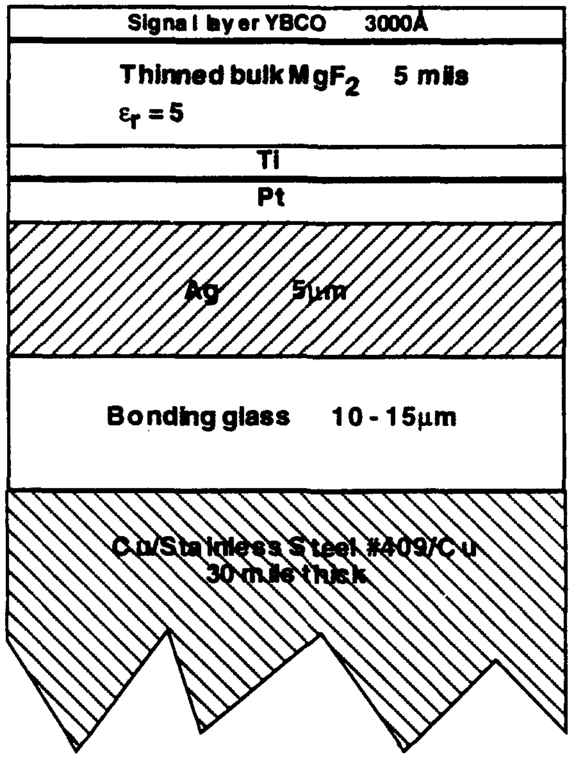

Figure 1. Demonstration structure for MCM Microwave/Millimeter Wave Applications.

III. **REFERENCES:** None

IV. **CHANGE IN KEY PERSONNEL:** None

V. **SUMMARY OF SUBSTANTIVE INFORMATION DERIVED FROM SPECIAL EVENTS:** None

VI. **ACTION REQUIRED BY THE GOVERNMENT:** None

VII. **FISCAL STATUS:**

1. Amount currently provided on contract:	\$1275K
2. Expenditures and commitments to date:	\$1167K
3. Funds required to complete work:	\$1585K